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Timber,
Forest Pest,
& Cooperative
Forestry
Management

Denver, Colorado

FOREST PEST CONDITIONS IN THE ROCKY MOUNTAIN REGION FOR 1989

FOREST PEST CONDITIONS

IN THE

ROCKY MOUNTAIN REGION

1989

By

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and

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June 1990

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The Forest Pest Management (FPM) Staff of the Timber, Forest Pest, and Cooperative Forestry Management Unit extends appreciation to all cooperators who contributed to this report. The cover was designed by Curtis O'Neil. The FPM staff organizational chart was produced by Deirdre Haneman.

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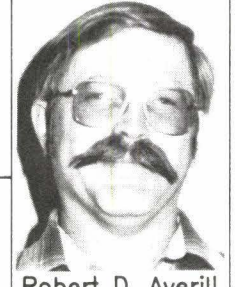

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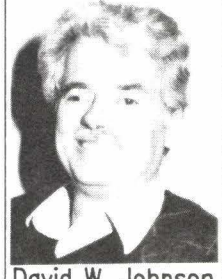

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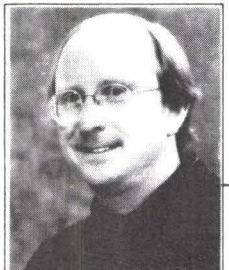

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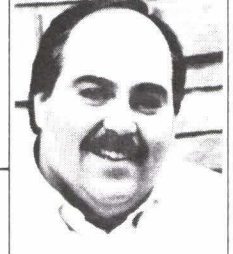

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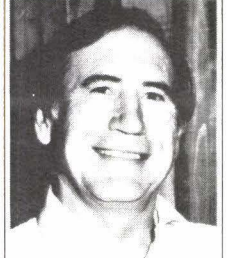

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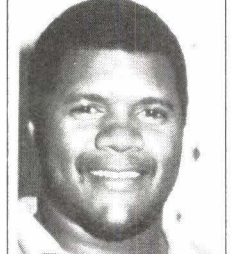

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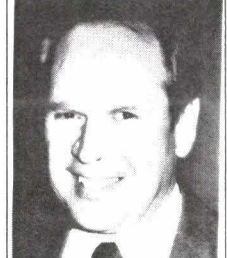

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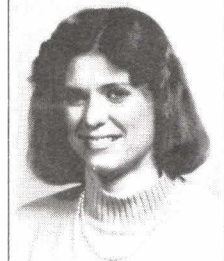

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INTRODUCTION

Forest Pest Management (FPM) is responsible for detection, evaluation, prevention and suppression of insects and diseases on forested Federal lands. Forest Pest Management also administers financial and technical assistance programs, which are available to State and private forest landowners through the Cooperative Forestry Assistance Act of 1978, Public Law (95-313).

DIRECTOR RETIRES

CHARLES W. FUDGE, Director of Timber, Forest Pest, and Cooperative Forestry Management for the Rocky Mountain Region, retired December 29, 1989, with 32 years of federal service.

Charlie was born and raised in Iowa. He earned a bachelor's degree in geology in 1956 from Iowa State University. Following two years in the U.S. Navy, he returned to forestry school at the University of Montana and graduated in 1961 with a bachelor's degree in forest management.

He began his Forest Service career in 1951 working as a seasonal on blister rust control on the old Cabinet National Forest in Region 1. He worked for five more seasons on the Cabinet and Kaniksu National Forests. In 1961, Charlie began his professional career as a forester on the Fortine Ranger District, Kootenai National Forest. He then moved to the Yaak Ranger District as an assistant ranger.

From 1968 to 1977, he was a district ranger on the Deer Lodge Ranger District, Deerlodge National Forest, and on the Ninemile Ranger District, Lolo National Forest. He served in the Lolo National Forest Supervisor's Office as timber management staff for two years and in the Northern Regional Office in timber sales and valuation for three years. Then from 1982 to 1986, he worked in the Washington Office as a staff assistant in timber sale programs and preparation. He came to the Rocky Mountain Region in August 1986 as Director of Timber, Forest Pest, and Cooperative Forestry Management.

His two daughters are married. Charlie and wife, Margaret, plan to remain in Denver during most of 1990. He plans to take woodworking courses, improve his Spanish language abilities, do geneological research, hit a few golf balls, and drown some worms in local lakes. Margaret and Charlie also are planning a few trips in their new 5th wheeler.

FOREST PEST MANAGEMENT SERVICE CENTERS

In addition to the central FPM office in Lakewood, Colorado, Service Centers were established in Gunnison, Colorado, and Rapid City, South Dakota, within the last year and a half. These offices provide service to all federal land management agencies, including the Forest Service, and coordination with State and private landowners in their area of operations. Activities include the traditional FPM roles of planning and implementing evaluations of insect and disease pests, and advising on technical phases of forest pest management operations.

Bernie Raimo is Supervisory Entomologist and Service Center Leader in Gunnison. Peter Angwin serves as the Center's Plant Pathologist.

The Gunnison Service Center is located at 216 North Colorado with the Cebolla and Taylor River Ranger Districts, the Soil Conservation Service, and the Bureau of Land Management Area Office. The Service Center provides assistance to the San Isabel and Rio Grande National Forests and to cooperators west of the Continental Divide in Colorado (Fig. 1).

Judith Pasek is Supervisory Entomologist and Service Center Leader in Rapid City, South Dakota. John Lundquist begins work as a Plant Pathologist in spring 1990 to support the activities of the Center.

The Rapid City Service Center is co-located with the Rocky Mountain Forest and Range Experiment Station at the Forestry Sciences Lab, South Dakota School of Mines and Technology. This Service Center provides assistance to cooperators east of the Continental Divide in northern Wyoming, all of South Dakota and Nebraska (Fig. 1).

Both Service Centers were established to provide timely and effective FPM services to their customers. Questions concerning Center operations and requests for service can be directed to the Director, TFP&CFM in the Regional Office or the respective Service Center Leaders.

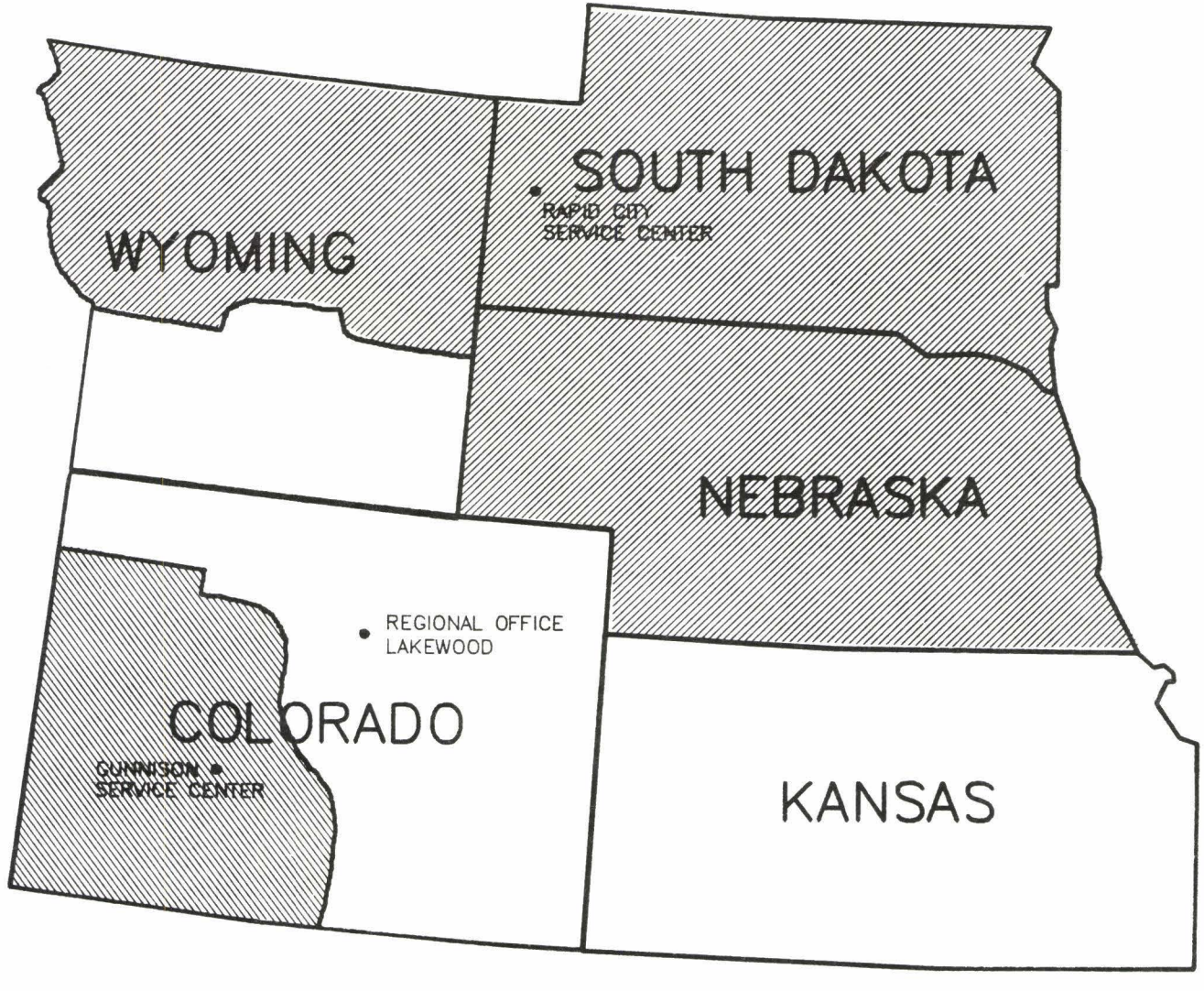

FIGURE 1. ROCKY MOUNTAIN REGION FOREST PEST MANAGEMENT ZONES.

FOREST PEST MANAGEMENT WORKSHOPS AND TRAINING

Tree Health Management Series

Six workshops throughout the United States and two exhibits at national and international conferences introduced the first instrument of the "Tree Health Management" series. Targeted were people who work with trees within areas of public use. The instrument, a video, reveals the state-of-the-art in hazard tree analysis. It is intended to sensitize, inform and educate people who care for trees and are concerned with public safety. Developed by Region 2 and marketed by the International Society of Arboriculture and the American Forestry Association, thousands of people have been exposed to the program. It is in use in five European countries, Australia and Canada. Within the United States hundreds of private companies and cities and twenty universities have incorporated the video into their programs or have been motivated to develop a program of tree health and risk management. The Public Affairs Office and the Cooperative Forestry Specialist in each region within the Forest Service have a copy of the video for internal use.

Insect and Disease Recognition and Management

A two day training session on insect and disease recognition and management in the Region was held in Custer, South Dakota (June 7-8). Twenty-four people attended from several federal agencies.

INSECT AND DISEASE CONDITIONS IN BRIEF

In 1989, aerial surveys were conducted on the Rio Grande National Forest and the Grand Mesa, Uncompahgre and Gunnison National Forests in Colorado and on the Black Hills National Forest in South Dakota. Data for acres affected by mountain pine beetle and western spruce budworm (Tables 1 & 2) were developed from these surveys along with some ground reconnaissance.

TABLE 1. ESTIMATES OF DAMAGE CAUSED BY MOUNTAIN PINE BEETLE BASED ON AERIAL AND GROUND SURVEYS IN REGION 2.

State	1988 Acres Affected	1989 Acres Affected	1989 Volume[1] Killed	1989 Number Of Trees Killed
Colorado	13,000	12,000	352	235,000
South Dakota	2,600	2,400	103	69,000
Wyoming	55,600	8,200	218	145,000

[1]Volume in thousand cubic feet of timber

TABLE 2. ACRES OF AERIALLY-DETECTED DEFOLIATION CAUSED BY WESTERN SPRUCE BUDWORM IN REGION 2.

State	1988	1989
Colorado	427,000	52,000
Wyoming	55,800	0

Mountain pine beetle and western spruce budworm damage levels are down throughout most of the Region. Mountain pine beetle is still a major problem on the Douglas Ranger District, Medicine Bow National Forest and on the Norwood Ranger District, Uncompahgre National Forest. Douglas-fir beetle populations and subsequent tree mortality increased throughout much of the Douglas-fir and mixed conifer type in Colorado. Most of the current infestation started in stands of Douglas-fir hard hit by budworm in the recent past. Douglas-fir beetle populations also are developing in large-diameter trees burned in the 1988 fires around Yellowstone Park. Pockets of tree mortality caused by pine engraver beetle (*Ips pini*) were prevalent throughout the Black Hills National Forest, on the Nebraska National Forest, and in shelterbelts across South Dakota. The *Ips* population increase is associated with continuing drought conditions in the Region.

The gypsy moth trapping program continued throughout the Region. No gypsy moths were caught on National Forest System lands in the Region during 1989. On other land ownerships, 3 moths were trapped in western Wyoming, 3 moths were trapped in southwestern South Dakota, 5 moths were trapped in eastern Nebraska, and 10 moths were trapped in Colorado. No moths were caught in traps within treatment areas following eradication efforts in Lakewood, Boulder, and Fort Collins West, but 5 of the moths trapped in Colorado were located in the Fort Collins East treatment area. Gypsy moths were introduced on transplanted nursery stock around Omaha, Nebraska.

Dwarf mistletoes continued as the most damaging disease agents in the Region. Survey and suppression activities for lodgepole pine dwarf mistletoe have continued in Colorado and Wyoming. Forest Pest Management funded presuppression surveys on 1,879 acres on three National Forests and silvicultural control on 1,797 acres on six National Forests.

The growth regulator ethephon has been tested in several sites on lodgepole pine and ponderosa pine dwarf mistletoes for effectiveness in reducing spread of the parasite. Continued monitoring of previous tests is planned.

Injury caused by a variety of environmental stress conditions was conspicuous throughout the Region in 1989. Widespread winter drying (redbelt) affected conifers throughout much of Colorado, Wyoming, South Dakota, and Nebraska. Most trees are expected to recover. Frost damage combined with drought-stress resulted in extensive branch dieback and tree mortality, especially in Siberian elm and weeping willow, throughout much of South Dakota, Nebraska, and Kansas. Additional tree mortality is expected in the next 1-2 years. Decline in vigor was apparent for a variety of tree species on the Great Plains, and has been attributed to drought stress.

Failure of a small percentage of aspen stands to regenerate successfully has resulted in a study of several sites in the Region. Continued investigation of the causes of aspen sprout failures is planned for the future.

Forest health in developed recreation areas is an ongoing concern in the Region. Comprehensive forest pest surveys were conducted at the Chapman campground (White River NF) and at six

campgrounds in the Taylor River Canyon (Gunnison NF). Vegetation management plans are in various stages of development.

The use of pesticides continues as an important part of integrated pest management. Pesticides are valuable tools in forest tree nursery management and control of noxious weeds and undesirable vegetation in range management. More than 19,000 acres were treated with pesticides in 1989.

The major cover types in the Region have age class distributions which are not conducive to a healthy forest. In all cases, the majority of the trees in a cover type are approaching maturity. Insects and diseases are expected to be a driving force, along with fire, in modifying the current vegetation.

DOUGLAS-FIR COVER TYPE

Western spruce budworm: *Choristoneura occidentalis* Freeman

Western spruce budworm populations continued their overall decline in the Region. About 50,000 acres were infested in Colorado. Severe defoliation of white spruce and Douglas-fir occurred at Spruce Basin at Cotopaxi, the southern end of South Park near Salida/Buena Vista, and on the Pike National Forest west of the US Air Force Academy near Colorado Springs. Aerial application of *Bt* to 140 acres of white spruce and Douglas-fir at Lake Purgatory development north of Durango provided satisfactory control.

Pheromone traps were placed by FPM at 46 sites along the Front Range in Colorado during 1989. Three traps per site were used. Average trap catch per site ranged from 0 to 38 insects. Average trap catches on the Roosevelt, Arapaho, Pike, and San Isabel National Forests were 0.1, 0.9, 1.4, and 23.2, respectively. Trap catches of western spruce budworm were highest at the Oak Creek sites on the San Isabel NF. The data will be used to calibrate a system that predicts defoliation that will occur in the year following trap catch.

The technique is expected to replace egg mass surveys, which have been used historically. The project is expected to continue for two to three years, or until a good correlation is obtained between predicted defoliation based upon trap catch and actual defoliation.

Douglas-fir tussock moth: *Orgyia pseudotsugata* McDonnough

Between 1983 and 1986, several small stands of Douglas-fir were severely defoliated along the Platte River drainage, Pike National Forest. That activity prompted the establishment of 60 permanent pheromone survey plots on the Pikes Peak and South Platte Ranger Districts in 1986. Plots were resurveyed in 1989, but no Douglas-fir tussock moths were caught.

Douglas-fir beetle: *Dendroctonus pseudotsugae* Hopkins

During the last decade, most of the Douglas-fir and mixed conifer forest types in the Region have experienced an outbreak of the western spruce budworm, (*Choristoneura occidentalis* Freeman). Several years of severe defoliation in these forest types have resulted in dead and dying stands of Douglas-fir. Following the budworm outbreak, Douglas-fir beetle populations have increased and infestations have spread from weakened trees that barely survived the budworm outbreak to healthier stands of Douglas-fir.

In Wyoming, salvage efforts are underway in several of the budworm-damaged and fire-scorched areas. In many of these stands, silviculturists are faced with the decision to do nothing and risk losing the Douglas-fir seed source or to do a seed cut and hope that opening the stand will improve the vigor of the seed trees and make them less susceptible to subsequent attacks. Where management objectives mandate the retention of a conifer cover type, e.g., in Douglas-fir stands being managed for big game winter thermal cover, the decision is a difficult one. Often, the trees best suited for retention are the larger-diameter trees in the stand which are also the most attractive to the Douglas-fir beetle. A cost-effective method to protect seed trees from Douglas-fir beetle attack would be a helpful tool for the silviculture of Douglas-fir in Colorado and Wyoming.

Field research using semiochemicals [MCH (3-methyl-2-cyclohexen-1-one)] to manage Douglas-fir beetle populations has shown some promising results. Plans are being developed to test semiochemicals (MCH) in several stands in Colorado and Wyoming. MCH acts as a repellent and shows potential for protecting high value trees.

In Wyoming, high brood production was present in large-diameter Douglas-fir blackened in 1988 by the Clover Mist fire on the Clarks Fork Ranger District of the Shoshone National Forest. Tree baits containing frontalin attractant will be used in 1990 to concentrate beetles in host trees around sale areas that could not be completely salvaged during 1989. Baited, infested trees will subsequently be removed to reduce the available population prior to 1991. The availability of many scorched, large-diameter Douglas-fir trees is expected to provide adequate host material for spread of the Douglas-fir beetle population in 1990.

Much of the area burned by the Clover Mist fire occurs in the Absaroka Wilderness where salvage and other treatment options are not appropriate or feasible. The Douglas-fir beetle infestation is likely to develop and increase in this area over the next few years due to the presence of large numbers of suitable hosts.

Douglas-fir dwarf mistletoe: *Arceuthobium douglasii* Engelm.

Dwarf mistletoe occurs on Douglas-fir in the southern two-thirds of Colorado. No suppression projects were funded by FPM during 1989 for this mistletoe species.

PONDEROSA PINE COVER TYPE

Mountain pine beetle: *Dendroctonus ponderosae* Hopkins

Mountain pine beetle populations have generally declined throughout the Region over the past 4 years, but in some areas the beetle continued to cause significant tree mortality.

In Colorado, a persistent mountain pine beetle outbreak which began around 1980 continued on approximately 12,000 acres of the Uncompahgre Plateau in the southwestern part of the state. Twenty-five percent of the 100,000 acres of pine type on the plateau remain at high risk.

Results of a ground survey conducted after the 1989 beetle flight indicate that tree mortality will continue at the current rate.

Two other species of *Dendroctonus*, the roundheaded pine beetle (*D. adjunctus* Blandford) and the western pine beetle (*D. brevicomis* LeConte), were also at unusually high population levels in this

area. High populations of these insects may be correlated with the below normal precipitation the area has experienced in the last few years.

An Environmental Impact Statement (EIS) describing alternatives for managing the pine type on the plateau will be completed in October 1990.

In Wyoming, tree mortality continued on about 9,750 acres on the Douglas Ranger District, Medicine Bow National Forest (refer to section on Cottonwood-Esterbrook project).

In South Dakota, the Black Hills National Forest showed a significant decrease in tree mortality caused by mountain pine beetle since the 1987 aerial survey. About 2,400 acres were affected, primarily between Bear Mountain and Deerfield Lake.

Cottonwood-Esterbrook Project--The Cottonwood-Esterbrook Integrated Pest Management Project, begun in July 1988 in Albany and Converse Counties in Wyoming, continued through 1989. The goal of this project is to manage the resources in the area in a manner that is not conducive to the development or perpetuation of pest problems. The objectives are listed in the 1988 report (Johnson, et al. 1989).

The project area covers approximately 173,440 acres and encompasses the Medicine Bow National Forest, Bureau of Land Management, State of Wyoming, and private lands. Private landowners are organized into the Laramie Peak Pine Beetle Association.

Examination of brood samples during July 1989 indicated a population decline due to winter mortality. A survey of beetle attacks conducted in October 1989 showed a ratio of 1989 to 1988 attacks of 0.4:1. The population reduction is expected to be temporary as is typical of most weather-related mortality factors. Management efforts are continuing as planned in the project area. The 1989 population reduction may provide additional implementation time for beetle control efforts.

Management of mountain pine beetle with semiochemicals--Field tests of the MPB anti-aggregation semiochemical, verbenone, were conducted in 1988 and 1989 on the Black Hills National Forest and on the Uncompahgre National Forest to determine the product effectiveness in reducing the number of beetle attacks in susceptible ponderosa pine stands. Five treatment rates were tested each year, ranging from 0 to 68 verbenone capsules per acre. None of the treatments were effective at reducing the number of trees attacked by the beetle in 1988 or 1989 tests. Following the 1988 tests, it was hypothesized that above average temperatures which followed early deployment of the capsules may have resulted in depletion of the material or changes in chemistry before the peak beetle emergence period. In 1989, quantitative and qualitative analyses of field-collected verbenone capsules were conducted periodically throughout the test period. Enough verbenone remained in the capsules at the end of the test period to discredit evaporation or chemical breakdown as a cause of treatment ineffectiveness. Another verbenone test is planned for 1990 on the Uncompahgre Plateau.

Pine engraver beetles: *Ips* species

Ips populations were prevalent in the Black Hills during 1989. Drier than normal weather likely contributed to their presence in standing trees. Infestations were abundant near thinning operations and in highly stressed trees. Scattered pockets were present from Custer to Spearfish in South Dakota and in the Bearlodge Mountains north of Sundance, Wyoming. Large pockets were present near Pactola Reservoir where a trail is being constructed and near Sheridan Lake where a 1987 prescribed burn damaged trees. Funnel traps baited with dienol attractant were used to mass trap beetles at Pactola Reservoir and on a number of privately-owned sites in the Black Hills. Additional

mass trapping is planned for 1990. *Ips* activity also was reported for several sites in Colorado and Nebraska.

Ponderosa pine dwarf mistletoe: *Arceuthobium vaginatum* (Willd.) Presl. subsp. *cryptopodum* (Engelm.) Gill.

Approximately 20 percent of the ponderosa pine type is infested with this mistletoe in Colorado. Annual losses amounted to over 885,000 cubic feet. Suppression projects were funded by FPM on 203 acres of mixed ponderosa pine and lodgepole pine on the Pike and San Isabel National Forests.

Control of ponderosa pine dwarf mistletoe with ethephon--Evaluations continued on the effects of the growth regulator ethephon on ponderosa pine dwarf mistletoe on the Black Forest, north of Colorado Springs, Colorado. Examination of trees the second year following treatments showed abscission rates of 57 to 76 percent indicating that some growth of new shoots occurred during the year. It is expected that silvicultural treatment of infected trees or reapplication of the chemical at some interval yet to be determined will be necessary to prevent continued spread of the parasite.

LODGEPOLE PINE COVER TYPE

Mountain pine beetle: *Dendroctonus ponderosae* Hopkins

Mountain pine beetle populations were generally low in lodgepole pine throughout the Region. Tree baits effectively contained a few small infestations at Vail and Beaver Creek ski areas in Colorado. A localized outbreak on about 30 acres was detected southwest of Ute Pass in the Pass Creek area of the Dillon Ranger District on the White River National Forest. The area is inaccessible by roads, but use of pheromone traps is planned for 1990 to control the beetle population.

Lodgepole pine dwarf mistletoe: *Arceuthobium americanum* Nutt. ex Engelm.

Approximately 50 percent of the lodgepole pine type is infested with dwarf mistletoe in Colorado. Combined estimates of annual growth and mortality losses on National Forest System lands alone in Colorado and Wyoming amount to over 10 million cubic feet.

Plans for survey and suppression of this mistletoe continued throughout the Region. Presuppression surveys were conducted on 1,879 acres on three National Forests. Cultural control was conducted on 1,797 acres on six National Forests (Table 3).

Control of lodgepole pine dwarf mistletoe with ethephon--Evaluations on the effects of the growth regulator ethephon on lodgepole pine dwarf mistletoe continued on the Arapaho National Forest in Colorado. Visual inspections of control plots on the Fraser Experimental Forest and at the Cutthroat Bay Campground were conducted in the summer of 1989. In separate tests, ethephon, at a rate of 2500 ppm in water with a surfactant, was applied during August with a bottle sprayer in 1983, a back pack mist blower in 1984, and a hydraulic sprayer in 1985. While more shoots were observed in 1989 than in 1988, many sprayed infections failed to resprout. It thus appears that additional spray applications may have the potential to reduce the overall number of active infections, and thereby reduce the number of subsequent new infections. Additional tests will be required to prove the above hypothesis.

Vegetation Management Projects In Developed Recreation Areas--Concern about forest health in developed recreation areas of the Rocky Mountain Region has resulted in the initiation of various vegetation management projects to deal with insect, disease, and hazard tree problems. In the summer of 1989, intensive surveys were conducted in the 83-unit Chapman Campground (White River NF) and in six campgrounds in the Taylor River Canyon (Gunnison NF). The surveys provided an estimation of the extent, distribution and severity of dwarf mistletoe, root disease, canker, insect and hazard tree problems, both within and immediately outside the campgrounds.

Lodgepole pine dwarf mistletoe was the major disease problem found at the Chapman Campground. Following the survey, a timber sale was marked within and adjacent to the campground, concentrating on the dwarf mistletoe centers. As part of the design of the sale, an interpretive trail was located in the sale area. Construction of the trail is planned to be multi-financed and built as part of basic fire training as a field exercise in fire line construction. FPM and recreation dollars will be used to develop and install the signing and brochure for the trail. Cutting in the sale is scheduled to commence in early spring, 1990. In the treatment areas, planting of conifer species that lack susceptibility to lodgepole pine dwarf mistletoe will be completed by students of the Aspen Middle School as part of a project to reduce the effects of global warming.

In the Taylor River Canyon, the survey results indicate that four of the six campgrounds assessed would benefit from mistletoe and hazard tree control. Detailed management plans to address these problems are currently being developed.

TABLE 3. ACRES OF PRESUPPRESSION SURVEYS AND SUPPRESSION PROJECTS FUNDED BY FPM AND CONDUCTED IN 1989 FOR DWARF MISTLETOE ON FEDERAL LANDS, MOSTLY IN LODGEPOLE PINE TYPE.

	Presuppression Survey Acres	Suppression Project Acres
National Forest		
Grand Mesa, Uncompahgre & Gunnison	0	216
Arapaho & Roosevelt	500	430
Routt	525	415
Pike & San Isabel	0	203
Shoshone	0	180
White River	854	353
TOTALS	1,879	1,797
Bureau of Land Management (USDI)		
Colorado	0	160
Wyoming	0	90
TOTALS	0	250

ENGELMANN SPRUCE COVER TYPE

Spruce beetle: *Dendroctonus rufipennis* (Kirby)

Low-level infestations continued at several locations in Colorado and Wyoming. Spruce beetle activity developed primarily in areas of spring flooding, windthrow, or accumulated logging slash. Timely salvage of infested trees was recommended for control at several sites.

Monitoring of spruce beetles with pheromone traps--Spruce beetles were monitored in two timber sales on the White River and Arapaho National Forests. Ten funnel traps baited with Consep® lures and ten traps containing Pherotech® lures were deployed in each timber sale area. Traps were checked weekly between June 26 and August 28. Spruce beetle flight peaked between June 30 and July 17. At Lime Creek, on the White River NF, about 2,900 beetles were caught in Consep®-baited traps and about 2,600 were caught in Pherotech®-baited traps. At Supply Creek, on the Arapaho NF,

about 16,200 and 24,000 beetles were caught in traps baited with Consep® and Pherotech® lures, respectively. No significant differences in attractiveness of the two types of lures were apparent when average weekly trap counts were compared. The Consep® lures were easier to load into the funnel traps.

ASPEN COVER TYPE

Aspen Regeneration Problem Survey--Interest in aspen utilization has increased in the Rocky Mountain Region. On some Forests the aspen harvest increased enough that occasional regeneration failures have caused concern. In southern Colorado, some unregenerated acres have converted to other vegetation.

Land managers need to be able to predict whether a given aspen stand might have problems regenerating. An FPM survey begun in summer 1988 and continued in 1989, was conducted to compare conditions in poorly-regenerating aspen cuts with similar cuts which were regenerating well. Data will be summarized in a formal report in spring 1990.

In looking at various stands throughout the Region, it is apparent that different sets of problems in the regeneration of aspen occur in different areas. For example, snow damage, dry sites, wet sites, herbivore pressure, competing understory, soil evolution, and disease may be variously involved.

Additional work in determining the etiology of sudden sprout mortality and factors involved in regeneration failure in general (especially soil relations) will be continued in a research project with Colorado State University cooperating with Forest Pest Management and the Rocky Mountain Forest and Range Experiment Station.

REGULATED PESTS

Gypsy moth: *Lymantria dispar* (Linnaeus)

The threat of gypsy moth introductions into the Region has increased during the past four years. Most isolated infestations of the gypsy moth result when egg masses are transported from generally infested areas on outdoor household goods, campers, vehicles, and any other items that provide accessible, protected sites for the female at egg-laying time. Vegetation on forested and unforested lands of all ownerships may be affected if gypsy moth populations become well established.

In 1989, detection surveys were again conducted in the five state area using sticky traps baited with gypsy moth sex attractant (pheromone). On National Forest System lands, 280 traps were placed in 140 high-use recreation sites that attract visitors from across the country as listed in Biological Evaluation R2-89-1 (Raimo, 1989). Additionally, 20 traps were placed along the Highway 20 corridor between Cody, Wyoming and Yellowstone National Park and near the Eagle Creek Campground on the Shoshone National Forest, where a gypsy moth was trapped in 1988. No gypsy moths were detected on NFS lands in 1989.

In Colorado, 3,075 detection traps (general survey to locate new introductions), 225 delimitation traps (higher density trapping to determine geographical limits of an infestation following initial detection), and 967 mass traps (high density trapping to control an infestation by attempting to catch all male gypsy moths in the area) were installed on state and private lands. Detection efforts were concentrated in human population centers below 10,000 feet in elevation. One moth was caught in Limon and two were caught in one trap in the Skyway section of Colorado Springs. Two moths were caught in detection traps at two widely-separated, previously-uninfested sites in Fort Collins. Citizen input led to the discovery near Rosita of contaminated household goods, which had been recently moved from northern New Jersey. All five areas will be monitored and mass-trapped in 1990.

Eradication efforts were conducted in areas of known infestation in Lakewood, Boulder, Fort Collins East and Fort Collins West. The Lakewood population, apparently established in 1987 (39 moths trapped) and trapped again in 1988 (43 moths caught), was mass-trapped in 1989 using 123 traps spaced at 9 traps/acre and ringed with 58 delimitation traps. No moths were caught in 1989. The area will be monitored again in 1990 to verify whether eradication has been accomplished (since according to APHIS definition, classification as eradicated requires two consecutive years of no catch when no organized chemical treatment was applied).

Six properties in Boulder were ground sprayed with Dipel® 4L on three dates in May. Additionally, mass trapping was conducted using 100 traps centered on two of the properties where moths were caught in 1988, and 100 delimitation and detection traps were placed in the surrounding area. Similar control efforts were conducted in Fort Collins West, where five properties were sprayed three times with Dipel® 4L and 216 mass traps and 55 delimitation traps were installed. No moths were caught at the Boulder and Fort Collins West sites during 1989. Mass trapping will be repeated in the Boulder and Fort Collins West areas in 1990.

In Fort Collins East, 469 mass traps were installed in a 5 block by 4 block area and surrounded by 62 delimitation traps. This treatment followed the use of the F1 sterile release technique in 1988. Five traps in the core area caught one moth each in 1989. Use of ground applications of *Bt* (*Bacillus thuringiensis*) is being considered for 1990.

In 1988, a number of single catches were found in detection traps in Ft. Collins and were assumed to be F1 moths that had escaped from the Fort Collins East treatment area. Each site was mass

trapped in 1989 using approximately 9 traps per site for a total of 59 traps. No moths were caught in these traps.

In Wyoming, about 766 detection traps were placed on state and private lands. Traps were placed in all sizeable urban areas as well as trailer parks, campgrounds, and recreational use areas that attract heavy use by out-of-state tourists. Two gypsy moths were trapped in Thermopolis and one was caught in Cody. Also, two moths were reported from Jackson (Region 4) and one moth in Yellowstone National Park (Region 1). Plans to monitor these areas are being developed by the responsible agencies.

In South Dakota, 996 detection traps were distributed to cooperators for placement on state and private lands. About 40% (401) were returned at the end of the trapping period. Two gypsy moths were trapped at the Rushmore KOA campground and one moth was trapped in Keystone, northeast of Mount Rushmore National Memorial. Delimitation surveys are planned for these two sites in 1990.

The Nebraska Department of Agriculture distributed 261 traps to nurseries and placed 108 traps at rest stops, airports, railyards, golf courses, nurseries, and Northwest Lincoln. USDA-APHIS placed 415 traps across Nebraska at RV parks, campgrounds, fishing areas, National Forest land, state parks, and reservoirs.

Gypsy moths were introduced on transplanted nursery stock in Omaha, Nebraska. Four moths were caught in traps at Lanoha Nursery and one moth was caught at Westside Nursery. Empty pupal skins also were observed in burlap trunk wrap during August. One gypsy moth also was caught at an RV park in North Platte, Nebraska.

No gypsy moth catches were reported for detection traps placed on state and private lands in Kansas.

URBAN AND SHELTERBELT TREE PROBLEMS

Botryodiplodia canker: *Botryodiplodia hypodermia* (Sacc.) Th. & Syd.

Cankers caused by the fungus *Botryodiplodia hypodermia* were associated with flagging and decline of Siberian elms in eastern Colorado and in shelterbelts throughout South Dakota. Herbicide damage was suspected as one stress factor predisposing trees to infection by the fungus.

Botryosphaeria canker: *Botryosphaeria stevensii* Shoem.

Branch dieback and mortality of eastern redcedar and Rocky Mountain juniper, caused by *Botryosphaeria stevensii*, continued to be a serious problem in windbreaks in scattered areas of eastern and central Nebraska. The fungus was first identified on juniper in Kansas in 1987. Reports of the disease have continued and many samples with the canker were received by the Kansas State University diagnostic center in 1989.

Bronze birch borer: *Agrilus anxius* Gory

Bronze birch borer continues to cause extensive branch dieback and tree mortality of ornamental paper birch in South Dakota. The situation likely was aggravated by drought conditions during the past 3 years. Many nurseries no longer stock paper birch.

Brown spot needle blight: *Scirrhia acicola* (Dearn.) Siggers

Brown spot on Scotch pine was severe in several windbreaks in southeast Kansas, but in general the reports of the disease were below normal.

Cedar-apple rust: *Gymnosporangium juniperi-virginiae* Schw.

Cedar-apple rust was heavy on both hosts (eastern redcedar, *Malus sp.*) in the Fleming-Haxtun area of northeast Colorado. Gymnosporangium rust on the hardwood hosts in South Dakota increased dramatically, especially in the east-central portion of the state. In contrast, the severity of the disease on its juniper hosts was significantly less than it was in 1988.

Cercospora blight: *Cercospora sequoiae* Ell. & Ev.

Cercospora blight of eastern redcedar and Rocky Mountain juniper continued to be a problem in windbreaks throughout much of eastern Nebraska.

Dioryctria moths: *Dioryctria ponderosae*, *D. tumicolella*, and *D. zimmermani* (Grote)

This complex of insects continues to cause considerable branch and trunk injuries to pines in localities in Nebraska, South Dakota, and Colorado. Past control efforts have often been ineffective because of the confused taxonomy and inadequate biological information. In Nebraska, presence of the 3 species was confirmed in 1989 as follows: *D. zimmermani* (Zimmerman pine moth) is present in the Omaha area; *D. ponderosae* is present in Thomas County on the Nebraska National Forest; and *D. tumicolella* is present in most of the central and western portions of the state. Based on biological observations, populations in southeastern South Dakota are suspected to be *D. tumicolella*.

Current control recommendations in Nebraska for *D. zimmermani* and *D. tumicolella* are to apply stem drenches of Dursban® during the second week of April and the second week of August. For *D. ponderosae*, apply stem drenches of Dursban® at the end of May and the second week of August.

Diplodia blight: *Sphaeropsis sapinea* (Fr.) Dyko & Sutton (= *Diplodia pinea* (Desm.) Kickx))

In Kansas and Nebraska, branch dieback and tree mortality were common in windbreaks and urban plantings of Austrian and ponderosa pines. Proper timing of fungicide applications can control the disease, but it must be applied several years in a row to get good control. Late infections in western Kansas followed a severe hail storm in July. In South Dakota, blight on ponderosa pine appeared to decline in both incidence and severity.

Dutch elm disease: *Ceratocystis ulmi* (Buism.) C. Mor.

In Colorado in 1989, Dutch elm disease (DED) evaluations were conducted in 91 CSFS Critical Areas statewide. A total of 553 samples from 49 areas were submitted to the CSFS laboratory for diagnosis. Of these, 412 (77%) were found to be positive for Dutch elm disease. This figure represents a decrease of over 100 cases from 1988 (down from 523 positives in 1988). The decline was largely due to local declines in disease incidence in Pueblo and Fremont counties. For most of the state, DED appeared to be declining or static due to sanitation efforts. Colorado had only 3 communities where reduced municipal efforts led to DED increases.

In South Dakota, the pest specialist in the state Division of Forestry assisted 13 communities with DED surveys. Based on those surveys and other reports, DED appeared to increase in severity in 1989. However, due to a decline in the number of susceptible elms in the eastern part of the state, the absolute number of trees reported killed by the disease was significantly less than in 1988. As the elm population declines, the epidemic is expected to subside. In western South Dakota, the disease continued as a major tree killer in woody draws.

In Kansas, Dutch elm disease increased, particularly in urban areas. The ongoing drought appeared to be a major contributing factor. While most communities have active sanitation programs in place, some lack funding and rely on homeowners to remove infected trees. Disease losses appeared to be greater in the latter communities.

In Nebraska, Dutch elm disease continued to be a problem throughout the state.

Elm leaf beetle: *Pyrrhalta luteola* (Muller)

Moderate to heavy defoliation of American and Siberian elms occurred in a number of urban communities in South Dakota, Nebraska, and Kansas. However, populations appeared to be collapsing in some areas following several years of epidemic levels. In eastern Nebraska, heavy mortality of first generation pupae was noted and few second-generation larvae and adults were observed during late summer in 1989. A similar population crash occurred in western Nebraska during 1988.

Fire blight: *Erwinia amylovora* (Burr.) Winsl. et. al.

Fire blight was reported as a serious disease of *Malus* (apple) species at the U.S. Air Force Academy in Colorado Springs. Several hundred trees have been lost to the bacterial blight. Intensive control measures are expected to slow the spread of the disease.

Foliage diseases of aspen: *Ciborinia whetzelii* (Seaver) Seaver
Marssonina populi (Lib.) Magn.

In 1989, reports of aspen leaf diseases of fungal origin were down. Found throughout the aspen type, these diseases create great aesthetic concern.

Japanese beetle: *Popillia japonica* Newman

The presence of Japanese beetle has steadily increased in eastern Nebraska since 1986. A total of 59 traps were placed statewide in 1989, 18 of them at a rest stop on Interstate 80 at Highway 77 North. Beetle catches at the rest stop were 112 in 1986, 318 in 1987, 366 in 1988, and 551 in 1989. Evidence

suggests that the insect is being introduced into the state on nursery stock. Of 22 nurseries monitored, Japanese beetles were trapped at 8 in Adams, Colfax, Douglas, and Lancaster Counties. Beetles also were detected at the Omaha Visitors Center. The pest feeds on a wide variety of hardwood ornamental species and turfgrass.

Oak wilt: *Ceratocystis fagacearum* (Bretz.) Hunt

Oak wilt appeared to be on the increase in Kansas. No new areas of infection were reported but the number of trees infected increased. Some of the reports were not verified in the laboratory, so more verification will be completed in 1990.

Phomopsis canker of Russian olive: *Phomopsis arnoldiae* Sutton

Continuing high levels of Phomopsis canker in shelterbelts throughout South Dakota were possibly coupled with high levels of herbicide damage. The general decline and dieback of Russian olive became a severe problem in windbreaks in eastern Kansas. Because no chemical controls are available, other tree species may need to be planted.

Pine engraver beetle: *Ips pini* (Say)

Tree mortality caused by pine engraver beetle was higher than normal in shelterbelts in South Dakota. The continuing drought conditions undoubtedly contributed to this situation.

Pinewood nematode: *Bursaphelenchus xylophilus* (Steiner et. Buhrer) Nickle

No pinewood nematode infected trees were confirmed during 1989. Sanitation is still the only recommended control for the disease.

Thyronectria canker: *Thyronectria austro-americana* (Speng.) Seeler

Thyronectria canker continued to be a major disease problem in urban plantings of honeylocust along the Colorado Front Range and in windbreaks in northwest Kansas.

ABIOTIC DISEASES

Winter Damage

Weather-related problems exerted considerable influence on tree vigor and survival during 1989. With the coming of the "Arctic Blast" storms, a severe drop from balmy conditions in late January (up to 80°F) to -30°F (or colder) in early February resulted in widespread damage throughout much of the region. Winter drying of conifers (redbelt) affected approximately 20,190 acres in Jefferson, Clear Creek, Gilpin, Boulder, El Paso, Park, Huerfano, Teller and Larimer counties in Colorado. Redbelt was also prevalent in the Pine Ridge of Nebraska, the Black Hills of South Dakota, and the Snowy Range, Sierra Madre, and Bighorn Mountains of Wyoming. Scientists at the USFS Rocky Mountain Forest and Range Experiment Station established permanent plots within the redbelt area on the Arapaho/

Roosevelt National Forest, where primarily lodgepole pine was affected, to monitor subsequent bark beetle activity and tree mortality. Widespread twig breakage also resulted from the freezing conditions. Little, if any mortality is expected. In contrast, the effects on many hardwood species were more severe. Throughout much of Kansas, Nebraska and South Dakota, frost damage to new buds in already drought-stressed Siberian elms and weeping willows resulted in widespread dieback and mortality. Estimates of the damage in Rapid City range as high as 70-80% of the Siberian elms. Some shelterbelts have been totally eliminated and it is expected that many of the affected trees will continue to decline and die over the next 3-5 years.

Drought

Throughout much of the region, 1989 was the second, and in some areas the third year in a row of severe drought. Reports of drought-related dieback were received from many counties throughout Kansas, Nebraska and South Dakota, affecting a wide variety of tree species. The widespread drought conditions have also affected the incidence and severity of many stress-related insect and disease problems. Even if these conditions were to end in 1990, drought-related problems may be expected to continue for the next several years.

Flooding

Pockets of mortality in ponderosa pine have long been noted in the Echo Basin area north of Mancos, Colorado. Chopping into affected trees releases a sour odor indicative of anaerobic conditions. The mortality is believed to be caused by a combination of surface water runoff from nearby flood-irrigated pastures and compaction from the movement of livestock.

Chemical Damage

In 1989, herbicide damage continued as a major source of requests for diagnostic assistance by state pathologists. Overall numbers of samples submitted with symptoms of chemical misuse were greater in 1989 than in 1988. Possibly the worst problem in the region resulted from special applications of the phenoxy herbicides 2,4-D and Ally® onto wheat fields in eastern Colorado and western Kansas. Application of the herbicides, under a 24-C ("special local needs") label, became necessary when dry conditions and sparse winter wheat development in the winter and spring led to heavy growth of weeds. Drift of the herbicides damaged many of the surrounding windbreaks. Elm, ash, and honeylocust were the species most severely affected. The full extent of the damage may not be known for several years.

Animal Damage

An evaluation of Vail and Beaver Creek ski areas found numerous pockets of porcupine-damaged lodgepole pines. Similar damage was also reported in ponderosa pine at the Mount Rushmore National Memorial in South Dakota. At the U.S. Air Force Academy in Colorado Springs, damage to younger plantations and ornamentals by pocket gophers, white tail deer, and mule deer also was reported.

NURSERY DISEASE PROBLEMS AND STUDIES

Nursery Inspections

The South Dakota State Division of Forestry's Big Sioux Tree Nursery in Watertown was surveyed twice in 1989. The disease problems of most concern included a severe leaf scorch of Amur maple, winter burn and winter kill of exposed 1-0 ponderosa, Scots, and Austrian pines, a dogwood root rot, shothole on chokecherry and plum, and unidentified "blights" in pear and crabapple. Subdue® fungicide will be tried on the dogwood planting beds in 1990 and two fungicides are being planned for use on the unidentified "blights" in the pear and crabapple. The unidentified Russian olive blight that was causing heavy losses a few years ago has been brought under control through increased spacing between rows in the beds.

The Nebraska Department of Agriculture inspected 171 nurseries, covering approximately 1,500 acres of nursery stock in 1989. Nurseries were reinspected three times during the growing season. The most common insect pests encountered, in decreasing order, were: borers (unknown spp.), bronze birch borer, *Dioryctria* spp. pine moths, pine tip moths, bagworm, spider mites, pine needle scale, *Neodiprion* sp. pine sawfly, hackberry nipplegall maker, aphid spp., and spruce needleminer. The most abundant diseases identified, in decreasing order, were: crown gall, cankers (unknown spp.), black knot, dothistroma needle blight, valsa canker, cedar-apple rust, dogwood leaf spot, Naemacyclus needle cast, and fire blight.

Nursery Studies

Evaluation of mycorrhizal development of 2-0 ponderosa pine from Bessey Nursery outplanted on the San Juan National Forest, Dolores R.D., showed that mycorrhizal development slowly increased over time. There was no correspondence between the size of a seedling (height times caliper) and its mycorrhizal development, after one or two years of growth at the outplanting site.

At the time of lifting in Fall 1987, mycorrhizal rating averaged 12% of the small roots of a seedling mycorrhizal. These seedlings were outplanted in 1988, and samples were pulled November 8, 1989. After two growing seasons, mycorrhizal development averaged 16% of the small roots of a seedling mycorrhizal.

At the time of lifting in Fall 1988, mycorrhizal development averaged 9% of the small roots of a seedling mycorrhizal. These seedlings were outplanted in 1989, and samples were pulled November 8, 1989. After one growing season, development averaged 14% of the small roots of a seedling mycorrhizal.

There was a broad range in mycorrhizal development. After one growing season, development ranged from zero to 40% of the small roots of a seedling mycorrhizal. After two growing seasons, development ranged from zero to 50% of the small roots of a seedling mycorrhizal. Since 46% of the sampled seedlings had roots badly stripped, the actual mycorrhizal development was probably better than observed in the lab. For ponderosa pine seedlings, mycorrhizal development of 5-15% is considered Low, 16-25% Moderate, and 26+% Good.

ROCKY MOUNTAIN REGION--SUMMARY OF INSECTS IN COLORADO, KANSAS, NEBRASKA, SOUTH DAKOTA, AND CENTRAL AND EASTERN WYOMING.

INSECT	HOST	LOCATION	REMARKS
A willow sawfly *Nematus* sp.	Willow	Wyoming	Severe defoliation was evident in localized areas on the Bighorn National Forest where plants had been frost-damaged earlier in the year.
Ash plant bug *Tropidosteptes amoenus*	Green ash	South Dakota	Damaging populations were reported throughout the eastern half of the state.
Balsam twig aphid *Mindarus abietinus*	Balsam fir	South Dakota	Considerable branch and tree mortality was detected in Union and Beadle Counties.
Bronze birch borer *Agrilus anxius*	Paper birch	South Dakota	This pest continued to be a major problem on ornamentals state-wide. Many nurseries are no longer selling paper birch.
Cankerworms *Alsophila pometaria* *Paleacrita vernata*	Boxelder, Hackberry, Honeylocust, Siberian elm	Kansas, South Dakota	Damage was low in most areas. Extensive defoliation occurred in southeastern Kansas on hackberry and elm trees. Some windbreaks, especially those containing Siberian elm, in central South Dakota were completely defoliated.
Common falsepit scale *Lecanodiaspis prosopidis*	Green ash, Hackberry, Red Mulberry	Colorado	In southeastern Colorado, the scale was heavy on dead branches of street trees, but branch mortality may have resulted from a combination of environmental stress and the presence of several scale species.
Cottonwood borer *Plectrodera scalator*	Cottonwood	South Dakota	Populations increased state-wide. Serious damage occurred in some windbreaks.
Dioryctria moths *Dioryctria ponderosae* *D. tumicolella* *Dioryctria* sp.	Austrian pine, Pinyon pine, Ponderosa pine, Scots pine	Colorado, Nebraska, South Dakota	This pest continued to be a serious problem throughout most of Nebraska and South Dakota. Damage was especially severe in southeastern South Dakota. A windbreak near Yellow Jacket, Colorado was heavily infested. Tip dieback was evident in pinyon pines near Canon City.
Douglas-fir beetle *Dendroctonus pseudotsugae*	Douglas-fir	Colorado, Wyoming	Populations that started in areas of recent heavy defoliation by western spruce budworm expanded into areas that have not been defoliated. Populations were high at Boulder Mountain Parks, Big Thompson Canyon, Ute Pass, and on the Pike National Forest and Air Force Academy lands near Colorado Springs. Populations increased on about 5,000 acres in the Soap Creek drainage north of Blue Mesa Reservoir in Colorado. Tree mortality declined along most of the rest of the front range. On the Shoshone National Forest in Wyoming, high populations developed in trees blackened by the Clover Mist Fire of 1988.

Elm calligrapha *Calligrapha scalaris*	Siberian elm	South Dakota	Heavy defoliation occurred in the southern third of the state, primarily in windbreaks.
Elm leaf beetle *Pyrrhalta luteola*	American elm, Siberian elm	Kansas, Nebraska, South Dakota	Several windbreaks in western Kansas were severely damaged, but populations were normal throughout the rest of the state. Moderate defoliation occurred throughout most of Nebraska and South Dakota. Severe defoliation occurred in Yankton, South Dakota.
European pine sawfly *Neodiprion sertifer*	Pine	Kansas	Damage increased considerably in eastern Kansas. Scots pine in Christmas tree plantations was hit especially hard and most growers applied chemical controls. The insect moved west, but damage was still light in western Kansas.
Gypsy moth *Lymantria dispar*	Hardwoods	Colorado, Nebraska, South Dakota, Wyoming	In Colorado, eradication programs were conducted in Lakewood, Boulder, and Fort Collins (East and West). No moths were caught in traps in Lakewood, Boulder, and Fort Collins West, but 5 moths were caught in Fort Collins East and 2 moths were caught at outlier locations in Fort Collins. Detection surveys were conducted throughout the 5-state region. In Colorado, 1 moth was caught in Limon and 2 were caught in Colorado Springs. A contaminated set of household goods was discovered near Rosita. In South Dakota, 3 moths were caught near Mt. Rushmore National Memorial in Keystone and at the Mt. Rushmore KOA Campground. In Wyoming, 2 moths were trapped in Thermopolis and 1 was caught near Cody. Nursery stock infested with gypsy moths were introduced into Omaha, Nebraska; 5 moths were caught in traps at 2 nurseries and empty pupal skins were located. One moth was caught at an RV park in North Platte, Nebraska.
Hackberry galls *Pachypsylla celtidismamma* *P. celtidisversicula*	Hackberry	South Dakota	Blister galls and nipple galls were numerous on foliage of trees in the southeastern quarter of the state and may have contributed to the poor health of these trees.
Honeysuckle aphid *Hyadaphis tataricae*	Honeysuckle	South Dakota	Damage continued state-wide.
Japanese beetle *Popillia japonica*	Hardwoods	Nebraska	Populations have steadily increased since 1986. Beetles appear to be entering the state on nursery stock. A total of 54 beetles were caught in traps at 8 out of 22 nurseries monitored in 1989. At a rest stop at I-80 and Hwy. 77, 551 beetles were caught. Soil applications of Triumph® 4E have been ineffective in reducing populations.

Lilac borer *Podosesia syringae*	Green ash, Lilac	Nebraska, South Dakota	This pest continues to be a problem in young ash trees and lilac in windbreaks and ornamental plantings. Reported incidence increased in South Dakota since 1988.
Mountain pine beetle *Dendroctonus ponderosae*	Limber pine, Lodgepole pine, Ponderosa pine	Colorado, South Dakota, Wyoming	Populations in South Dakota were low and concentrated between Bear Mountain and Deerfield Lake in the Black Hills. In Wyoming, populations continued at epidemic levels on about 9,750 acres in the Laramie Peaks area of the Medicine Bow National Forest, where salvaging is being continued. Populations were at endemic levels throughout most of Colorado. The outbreak on the Uncompahgre Plateau continued in ponderosa pine. An outbreak was detected on about 30 acres southwest of Ute Pass on the White River National Forest. Tree baits effectively contained a few small pockets in lodgepole pine at Vail and Beaver Creek ski areas. Populations in Estes Valley increased to early epidemic proportions.
Pandora moth *Coloradia pandora*	Ponderosa pine	South Dakota	A small outbreak was detected in the southern Black Hills. Second-year larvae caused noticeable defoliation.
Pine engraver beetle *Ips pini*	Ponderosa pine, Jack pine	Colorado, Nebraska, South Dakota, Wyoming	Infestations were abundant in ponderosa pine throughout most of the Black Hills in South Dakota and Wyoming, particularly near thinning operations and in highly stressed trees. Large pockets were present near Pactola Reservoir, Sheridan Lake, Lead, and the Bear Lodge Mountains. Some activity was present in Summit and Eagle Counties in Colorado. In Nebraska, beetles predominated in jack pine log decks and in ponderosa pine that was highly stressed or near thinning operations.
Pine tip moths *Rhyacionia bushnelli* *Rhyacionia frustrana*	Austrian pine, Pinyon pine, Ponderosa pine, Scots pine	Colorado, Kansas, Nebraska, South Dakota	Damage was light in Christmas tree plantations and nurseries where chemical control is often used. Young pines in windbreak and landscape plantings continued to be damaged throughout the plains and in metro areas of Colorado. Greater than normal populations of Nantucket pine tip moth were reported in southcentral Kansas. Western pine tip moth was reported for the first time near Paoli, Colorado. Pine regeneration in the southern Black Hills of South Dakota was heavily damaged.
Pinyon pitch-nodule moth *Retinia arizonensis*	Pinyon pine	Colorado	Some tip dieback was observed at Garden of the Gods Park in Colorado Springs.
Roundheaded pine beetle *Dendroctonus adjunctus*	Ponderosa pine	Colorado	Populations were present on the Uncompahgre Plateau in conjunction with mountain pine beetle and western pine beetle.

Spruce beetle *Dendroctonus rufipennis*	Engelmann spruce	Colorado, Wyoming	Populations were at endemic levels in scattered windthrown spruce and logging slash. Active infestations were detected west of Denver in areas subjected to high water during spring runoff. Damage also was present at the Air Force Academy near Colorado Springs and on the Bear Ears Ranger District of the Routt National Forest; commercial thinning or salvage sales are planned for these areas.
Tent caterpillars *Malacosoma americanum* *M. californicum* *M. disstria*	American plum Chokecherry Hardwoods	Colorado South Dakota	Defoliation by western tent caterpillar continued in the Chama Basin on the southern end of the Rio Grande National Forest. Eastern tent caterpillar caused nearly complete defoliation of American plum and chokecherry in northeastern South Dakota and in counties along the Missouri River. An outbreak of forest tent caterpillar reported in northeastern South Dakota in 1988 collapsed in 1989.
Twig beetles *Pityophthorus* sp.	Ponderosa pine	Colorado	Flagging of branches was detected in the Black Forest.
Ugly nest caterpillar *Archips cerasivorana*	Chokecherry	South Dakota	Nearly complete defoliation occurred in many windbreaks along the Missouri River in central South Dakota. Pupal parasitism was high, so the outbreak is not expected to last long.
Walnut caterpillar *Datana integerrima*	Pecan Walnut	Kansas	Damage increased, especially in southeastern Kansas. Complete defoliation occurred in some areas.
Western pine beetle *Dendroctonus brevicomis*	Ponderosa pine	Colorado	Populations were detected in conjunction with mountain pine beetle and roundheaded pine beetle on the Uncompahgre Plateau.
Western spruce budworm *Choristoneura occidentalis*	Douglas-fir, Engelmann spruce, Subalpine fir, White fir	Colorado, Wyoming	Populations declined or continued at endemic levels in most areas that were infested in recent years. Severe defoliation occurred at several locations in Colorado: Spruce Basin at Cotopaxi, the southern end of South Park near Salida/Buena Vista, and on the Pike National Forest west of the US Air Force Academy near Colorado Springs. Aerial application of *Bt* to 140 acres at Lake Purgatory development north of Durango provided satisfactory control. About 50,000 acres were infested in Colorado.
White pine weevil *Pissodes strobi*	Colorado blue spruce	Colorado	Typical top-kill and leader deformity was detected in 12% of trees examined in the Upper Bear Creek Valley near Kittredge. Most damage was in sapling and pole-size trees.

ROCKY MOUNTAIN REGION--STATUS OF DISEASES IN COLORADO, KANSAS, NEBRASKA, SOUTH DAKOTA, AND CENTRAL AND EASTERN WYOMING.

DISEASE	HOST	LOCATION	REMARKS
STEM AND BRANCH DISEASES			
Comandra blister rust *Cronartium comandrae*	Lodgepole pine	Colorado, Wyoming	Comandra blister rust continued as the most serious disease of lodgepole pine on the Wind River Ranger District, Shoshone National Forest, where more than half of the mature trees were infested and 85 percent of infected trees had dead tops. The disease was present but not a management problem in northern Colorado.
Western gall rust *Endocronartium harknessii*	Lodgepole pine, Ponderosa pine	Colorado, South Dakota	Western gall rust was reported as a problem in lodgepole pine on the White River National Forest in Colorado and in ponderosa pine in the Black Hills and at Mount Rushmore National Memorial in South Dakota.
Dwarf mistletoes *Arceuthobium americanum*	Lodgepole pine	Colorado, Wyoming	Dwarf mistletoes remained the most important disease on federal lands in the region. The disease was found on about 518,000 acres in Colorado and 361,000 acres in Wyoming, and caused mortality and growth loss equal to approximately 10 million cubic feet. In 1989, FPM funded presuppression surveys on 1,879 acres on three National Forests and silvicultural control on 1,797 acres on six National Forests.
Arceuthobium douglasii	Douglas-fir	Colorado	There were reports of many trees killed in recreational areas and homesites in the mountains west of Colorado Springs. Scattered occurrence was reported at the Air Force Academy. The disease also was reported as a factor affecting management on the Southern Ute Reservation in southern Colorado.
Arceuthobium vaginatum subsp. *cryptopodum*	Ponderosa pine	Colorado	Approximately 20 percent of the host type was infested. Annual losses amounted to over 885,000 cubic feet. The disease was reported as a factor affecting management on the Southern Ute Reservation and at the Air Force Academy.
Arceuthobium divaricatum	Pinyon pine	Colorado	Pinyon pine dwarf mistletoe continued as a minor problem in western Colorado.
CANKERS			
Thyronectria austro-americana	Honeylocust	Colorado, Kansas	This was a major disease problem in urban plantings along the Colorado Front Range and continued to be a problem in Kansas windbreaks.
Botryodiplodia spp.	Juniper	Kansas	This continued to be a problem in windbreaks.

Botryodiplodia hypodermia	Siberian elm	Colorado, South Dakota	Cankers were associated with flagging and decline in eastern Colorado. Elm decline continued throughout South Dakota. Herbicide damage is suspected as a predisposing factor to infection by this fungus.
Botryosphaeria stevensii	Eastern redcedar, Rocky Mountain juniper	Kansas, Nebraska	This was a serious problem in scattered areas of Kansas and eastern and central Nebraska.
Phomopsis or *Tubercularia* sp.	Russian olive	Kansas, South Dakota	This disease continued to cause serious decline and mortality in windbreaks in eastern Kansas and throughout South Dakota.
ROOT DISEASES			
Armillaria root disease *Armillaria* spp.	Engelmann spruce, Lodgepole pine, Subalpine fir, White fir	Colorado	*Armillaria* root disease was the most common root disease in the state. The potential for damaging losses is unknown at this time. The disease is affecting management of mixed conifer stands on the Southern Ute Reservation.
Annosus root disease *Heterobasidion annosum*	White fir	Colorado	The disease was reported as a factor affecting management of mixed conifer stands on the Southern Ute Reservation.
Black stain root disease *Leptographium wageneri*	Pinyon pine	Colorado	Blackstain root disease caused widespread scattered mortality in southwest Colorado.
FOLIAGE DISEASES			
Gnomonia leptostyla	Walnut	Kansas	This was not a problem this year due to dry weather. Some seedling damage was observed in eastern Kansas.
Ciborinia whetzelli *Marssonina populi*	Aspen	Colorado, South Dakota	Found throughout the aspen type, these diseases create great aesthetic concern. Fewer incidents were reported this year than last year.
Diplodia blight *Sphaeropsis sapinea* (=*Diplodia pinea*)	Austrian pine, Ponderosa pine	Kansas, Nebraska, South Dakota	Branch dieback and tree mortality were common in windbreaks and urban plantings. Late infections were observed in western Kansas following a severe hailstorm in July. In South Dakota, a decline in the amount and severity of Diplodia blight of ponderosa pine was observed.
Fire blight *Erwinia amylovora*	Apple, Crabapple	Colorado	Several hundred trees were killed on the Air Force Academy.
Gymnosporangium juniperi-virginianae	Apple species, Eastern redcedar, Juniper	Colorado, South Dakota	Galls on cedar were extremely heavy in northeast Colorado. In south and east-central South Dakota, disease severity increased dramatically on the hardwood hosts, but decreased on the juniper hosts.

Scirrhia acicola	Scots pine	Kansas	Reports were less numerous than usual, but the disease was quite severe in several windbreaks in southeast Kansas.
Needlecasts			
Cercospora sequoiae	Eastern redcedar, Rocky Mountain juniper	Nebraska	This continued to be a problem in windbreaks.
Dothistroma pini	Austrian pine	Nebraska	The disease was a problem on young trees in scattered areas.
WILTS AND DECLINES			
Dutch elm disease			
Ceratocystis ulmi	Elm species	Colorado, Kansas, Nebraska, South Dakota	There was a statewide decline in incidence in Colorado. However, Dutch elm disease remains top priority for control in Colorado's urban forests. In South Dakota, the disease continued to annually kill 6 to 10 percent of the American elms in communities without management programs. Disease incidence increased in Kansas. In Nebraska, the disease continued to be a problem.
Oak wilt			
Ceratocystis fagacearum	Oak species	Kansas	Oak wilt appeared to be on the increase in Kansas. No new areas of infection were reported but the number of infected trees increased.
Pinewood nematode			
Bursaphelenchus xylophilus	Scots pine	Kansas	No infected trees were confirmed in 1989. Sanitation is still the only recommended control measure.
OTHER			
Chemical damage	Many tree species	Colorado, Kansas	Herbicide damage to windbreaks in eastern Colorado and western Kansas was much greater than usual. Dry conditions through the winter and spring led to delayed wheat development and heavy weed growth, which in turn led to special applications of 2,4-D/Ally®. Widespread drift problems damaged many windbreaks. The full extent of the damage will not be known for several years.
Unknown decline	Ponderosa pine	Colorado	A general recovery of pine from the mid-'80's was noted in the San Juan Basin in southwestern Colorado.
Sprout dieback	Aspen	Colorado	Mortality of few to several-year-old sprouts occurred infrequently after harvest of aspen stands. Snow damage, dry sites, wet sites, herbivore pressure, competing understory, soil evolution, and disease may be variously involved.
Porcupine feeding	Lodgepole pine Ponderosa pine	Colorado South Dakota	Locally common damage was reported at the Vail and Beaver Creek ski areas in Colorado and at Mt. Rushmore National Memorial in South Dakota.

Winter drying injury	Douglas-fir, Juniper, Lodgepole pine, Pinyon pine Ponderosa pine, Siberian elm, Weeping willow	Colorado, Kansas, Nebraska, South Dakota, Wyoming	A sudden drop from balmy conditions in late January to -30°F (or colder) in early February led to widespread winter drying (redbelt) on approx. 20,190 acres in Jefferson, Clear Creek, Gilpin, Boulder, El Paso, Park, Huerfano, Teller and Larimer counties in Colorado. Winter drying was also prevalent in the Pine Ridge of Nebraska, Black Hills of South Dakota, and Bighorn Mountains in Wyoming. Very little, if any mortality is expected. Frost damage to new buds in Siberian elm and weeping willows throughout Kansas, South Dakota and western Nebraska resulted in a loss of 50% or more of the crowns of many affected trees.
Drought, other unknown agents	Black walnut, Blue spruce, Buffaloberry, Dogwood, Mulberry, Pear, Ponderosa pine, Russian olive, Siberian elm, Silver maple	Kansas, Nebraska, South Dakota	Drought and abnormally high temperatures affected trees in many counties throughout Kansas, Nebraska, and South Dakota.
High water	Ponderosa pine	Colorado	Pockets of mortality were noted north of Mancos, Colorado.

USE OF HERBICIDES IN REGION 2 FOR 1985-1989 (MAJOR HERBICIDE USES ONLY)1/

HERBICIDE	APPLICATION METHOD	1985	1986	1987	1988	1989
				Acres Treated		
2,4-D	Ground	2,243	2,857	2,592	4,623	6,688
Picloram (Tordon)	Ground	2,452	3,167	2,769	3,945	2,808
Glyphosate (Roundup)	Ground	102	244	387	100	384
Dicamba (Banvel)	Ground	292	295	600	469	1,337

1/ Major target species are big sagebrush, sand sagebrush, Canada thistle, leafy spurge, *Wyethia* spp. and various broadleaf weeds for range improvement and roadside management projects.

PESTICIDE USE IN REGION 2 IN FY 89 [1/]

Type of Pesticide	Chemical Used	Target Pest	Units Treated [2/]
Fumigant	Methyl bromide/ chloropicrin	Nematodes and Fusarium in nursery beds	13
Fungicide	Benomyl	Phomopsis canker in eastern redcedar nursery stock	36
	Dazomet	Nematodes in nursery beds	1
	Dodine	Shothole disease in nursery stock	6
Herbicide	Atrazine	Firebreak management	50
	Cacodylic acid	Noxious weed control	10
	Dacthal	Nursery weed control	17
	Dicamba	Noxious weed control	1,337
	Dicamba	Poisonous plant control	40
	Diuron	Firebreak management	50
	Diuron/Bromacil	General weed control	6
	Fosamine ammonium	Firebreak management	1
	Glyphosate	General weed control	384
	Hexazinone	Site preparation	3
	Imazapyr	Conifer release	1
	Picloram	Noxious weed control	2,808
	Tebuthiuron	Range vegetation improvement	330
	Telar	Noxious weed control	182
	2, 4-D	Noxious weed control	1,853
	2, 4-DP	Noxious weed control	80
	2, 4-D	Range management improvement	390
	2, 4-D/Dicamba	Noxious weed control	182
	2, 4-D/Picloram	Noxious weed control	4,183
Insecticide	Carbaryl	Cottonwoood leaf beetle	4
	Carbaryl	Mountain pine beetle	20
	Coumaphos	Lice, mites, ticks	14,000 head of cattle
	Dimethoate	Tip moths	6
Rodenticide	Aluminum phosphide	Prairie dogs	248
	Zinc phosphide	Prairie dogs	6,858
	Zinc phosphide	Prairie dogs	300 burrows

1/ Includes use by the USDA Forest Service, other federal agencies, permittees, licensees, and grantees.

2/ Units are in acres unless otherwise indicated.

RECENT PUBLICATIONS (as of 4/90)

Angwin, P.A. 1989. Genetics of sexuality and population genetics of *Phellinus weirii*. Ph.D. Thesis, Oregon State University. 175 p.

Angwin, P.A.; and E.M. Hansen. 1988. Population structure of *Phellinus weirii*, p. 371-380, *In*: Morrison, D. [ed.]. 7th Int. Conf. Root and Butt Rot In Conifers, Int. Union For. Res. Org, August 8-16, 1988, Victoria, B.C.

Bailey, D.K.; and F.G. Hawksworth. 1988. Phytogeography and taxonomy of the pinyon pines. *Pinus* subsection *Cembroides*, p. 41-64. *In*: Passini, M.; D.C. Tovar; and T.E. Piedra [compliers]. II Simposio Nacional sobre Pinos Pinoneros, August 6-8, 1987, Mexico City, Mexico. Centre d' Etudes Mexicaines et Centroamericaines, Mexico City, Mexico.

Baker, F.A.; and A. Lynch. 1990. Assessing pest impacts on non-timber resources, p. 38. *In*: James R.L.; and R.L. Livingston [compilers]. Proceedings of the Thirty-seventh Annual Western International Forest Disease Work Conference, September 11-15, 1989, Bend, OR. USDA For. Serv., Coeur d'Alene, ID. 154 p.

Barlow, B.A.; F.G. Hawksworth; J. Kuijt; R.M. Polhill; and D. Wiens. 1989. Genera of mistletoes. The Golden Bough, Royal Botanic Gardens, Kew, England, No. 11: 1-4.

Bentz, B.; C.K. Lister; J.M. Schmid; S.A. Mata; L.A. Rasmussen; and D. Haneman. 1989. Does verbenone reduce mountain pine beetle attacks in susceptible stands of ponderosa pine? USDA For. Serv., Rocky Mountain For. and Range Expt. Sta. Research Note RM-495. 4 p.

Boyd, J.E.; and W.R. Jacobi. 1989. The development of a risk rating system for comandra rust in lodgepole pine, p. 73-77. *In*: Proceedings of the 36th Western International Forest Disease Work Conference, September 20-23, 1988, Park City, UT. 153 p.

Dix, M.E. 1989. Can attractants be used to manage insect pests of windbreak trees?, p. 231-234. *In*: Proceedings of the 1988 Society of American Foresters National Convention "Healthy Forest, Healthy World," October 16-19, 1988, Rochester, New York. Society of American Foresters Publication 88-01. Bethesda, MD. 424 p.

Dix, M.E.; and R.C. Cunningham. 1990. Host preferences of cankerworms in Siberian elm windbreaks. *In*: Proceedings of the informal conference "Insects of windbreaks and related plantings: Distribution, importance and management," 1988 National Entomological Society of America Conference, December 4-8, 1988, Louisville, Kentucky. USDA For. Serv. Gen. Tech. Rep. RM- . Rocky Mountain For. and Range Expt. Sta., Fort Collins, CO. (In Press).

Dix, M.E.; and M.O. Harrell. 1990. Opportunities for managing borers in windbreak trees with attractants. *In*: Proceedings of the informal conference "Insects of windbreaks and related plantings: Distribution, importance and management," 1988 National Entomological Society of America Conference, December 4-8, 1988, Louisville, Kentucky. USDA For. Serv. Gen. Tech. Rep. RM- . Rocky Mountain For. and Range Expt. Sta., Fort Collins, CO. (In Press).

Dix, M.E.; and D. Leatherman. 1990. Insect pest management in windbreaks, p. 242-246. *In*: Proceedings of the 1989 Society of American Foresters National Convention "Forestry on the frontier," September 24-27, 1989, Spokane, Washington. Society of American Foresters Publication, Bethesda, MD.

Eav, B.; R.R. Johnson; C.G. Shaw. III; and A.R. Stage [tech. coord.]. 1989. Integrating pest impact information in the next planning cycle: implementation plan. USDA For. Serv., Forest Pest Mgmt., Methods Application Group, Fort Collins, CO. Unnumbered report. 21 p.

Filip, G.M.; D.J. Goheen; D.W. Johnson; and J.H. Thompson. 1989. Precommercial thinning in a ponderosa pine stand affected by armillaria root disease: 20 years of growth and mortality in central Oregon. Western Journal of Applied Forestry 4: 58-59.

Geils, B.; and R. Alfaro. 1990. Topkill caused by insects and diseases, p. 76. *In*: James R.L.; and R.L. Livingston [compilers]. Proceedings of the Thirty-seventh Annual Western International Forest Disease Work Conference, September 11-15, 1989, Bend, OR. USDA For. Serv., Coeur d'Alene, ID. 154 p.

Guyon, J.C.; W.R. Jacobi; and G.A. McIntyre. 1989. The effect of environmental stress on Cytospora canker of aspen, p. 78-81. *In*: Proceedings of the 36th Western International Forest Disease Work Conference, September 20-23, 1988, Park City, UT. 153 p.

Harrell, M.O. 1989. Preemergent herbicide use guide for tree and shrub plantings. Univ. Nebr. For. Pests of Nebr. Leaflet No. 23. 1 p.

Harrell, M.O. 1990. Role of host susceptibility and site influences on damage caused by Dioryctria pine borers. *In*: Proceedings of the informal conference "Insects of windbreaks and related plantings: Distribution, importance and management," 1988 National Entomological Society of America Conference, December 4-8, 1988, Louisville, Kentucky. USDA For. Serv. Gen. Tech. Rep. RM- . Rocky Mountain For. and Range Expt. Sta., Fort Collins, CO. (In Press).

Harrell, M.O. 1989. Zimmerman pine moth control in the Omaha area. Univ. Nebr. For. Pests of Nebr. Leaflet No. 21. 1 p.

Harrell, M.O. 1989. Zimmerman pine moth control in central and western Nebraska. Univ. Nebr. For. Pests of Nebr. Leaflet No. 22. 1 p.

Harrell, M.O.; A.R. Martin; D.M. Adams; and T.D. Wardle. 1990. Chemical weed control in first-year tree plantings. Univ. of Nebr., Nebr. For. Serv. Misc. Publ. 2 p.

Harrell, M.O.; and P.A. Pierce. 1989. AVID trunk injection as a control for elm leaf beetle. Insecticide and Acaricide Tests 14: 342.

Hawksworth, F.G. 1989. A second introduction of *Viscum album* in North America. The Golden Bough, Royal Botanic Gardens, Kew, England, No. 11: 5.

Hawksworth, F.G.; and D.K. Bailey. 1989. Pine trivia. Journal of Forestry 87(11): 28-30.

Hawksworth, F.G.; and R. Fletcher. 1989. Kiss of death for mistletoes, p. 5-8. USDA For. Serv., Forestry Research West, March issue.

Hawksworth, F.G.; and D.W. Johnson. 1989. Panel - Mistletoe control with ethephon, p. 29-45. *In*: Proceedings of the 36th Western International Forest Disease Work Conference, September 20-23, 1988, Park City, UT. 153 p.

Hawksworth, F.G.; and D.W. Johnson. 1989. Biology and management of dwarf mistletoe in lodgepole pine in the Rocky Mountains. USDA For. Serv., Rocky Mountain For. and Range Exp. Sta. Gen. Tech. Rep. RM-169. 38 p.

Hawksworth, F.G.; and C.G. Shaw, III. 1988. Damage and control of major diseases of ponderosa pine, p. 99-108. *In*: Baumgartner D.M.; and J.E. Lotan [editors]. Ponderosa Pine, the Species and its Management, Symposium Proceedings, Washington State University, Cooperative Extension.

Hawksworth, F.G.; C.G. Shaw, III; and B. Tkacz. 1989. Damage and control of diseases of Southwest ponderosa pine, p. 116-129. *In*: Tecle, A.; W.W. Covington; and R.H. Hamre [tech. coords.]. Multiresource Management of Ponderosa Pine Forest, November 14-16, 1989, Flagstaff, Arizona. USDA For. Serv., Gen. Tech. Rep. RM-185, 282 p.

Hawksworth, F.G.; and D. Wiens. 1989. Two new species, nomenclatural changes, and range extensions in Mexican *Arceuthobium* (Viscaceae). Phytologia 66: 3-11.

Heisler, G.M.; and M.E. Dix. 1990. Effects of windbreaks on local distribution of airborne insects. *In*: Proceedings of the informal conference "Insects of windbreaks and related plantings: Distribution, importance and management," 1988 National Entomological Society of America Conference, December 4-8, 1988, Louisville, Kentucky. USDA For. Serv. Gen. Tech. Rep. RM- . Rocky Mountain For. and Range Expt. Sta., Fort Collins, CO. (In Press).

Hildebrand, D.M. 1989. A review of soil solar heating in western forest nurseries, p. 49-51. *In*: Landis, T.D. [tech. coord.]. Proc. Intermtn. For. Nursery Assoc., Aug 14-18, 1989, Bismarck, ND. USDA For. Serv., Rocky Mountain For. and Range Exp. Sta. Gen. Tech. Rep. RM-184.

Hildebrand, D.M.; and G.B. Dinkel. 1989. Evaluation of methyl bromide, Basamid granular, and solar heating for pre-plant pest control for fall-sown eastern redcedar at Bessey Nursery. USDA For. Serv., Timber, Forest Pest and Cooperative Forestry Mgmt., Rocky Mountain Region Tech. Rep. R2-41, 13 p.

Hodges, C.S., Jr.; and G.W. Peterson. 1989. Cercospora blight of juniper. p. 29-30. *In*: Cordell, C.E.; et al. [tech. coords.]. Forest Nursery Pests. USDA For. Serv. Agri. Handbook 680. 184 p.

Jacobi, W.R.; and J.W. Riffle. 1989. Effects of water stress on Thyronectria canker of honeylocusts. Phytopathology 79: 1333-1337.

Jennings, D.T.; F.B. Penfield; R.E. Stevens; and F.G. Hawksworth. 1989. Spiders (Araneae) associated with dwarf mistletoes (*Arceuthobium* sp.) in Colorado. Southwestern Naturalist 34: 349-355.

Johnson, D.W. 1990. Dwarf mistletoe program planning for the Rocky Mountain Region--1990-1994. USDA For. Serv., Timber, Forest Pest and Cooperative Forestry Mgmt., Rocky Mountain Region Tech. Rep. R2-46, 8 p.

Johnson, D.W.; and D.M. Hildebrand. 1989. Effects of application rate and timing of ethephon treatments on abscission of ponderosa pine dwarf mistletoe - a status report. USDA For. Serv., Timber, Forest Pest and Cooperative Forestry Mgmt., Rocky Mountain Region Tech. Rep. R2-45, 8 p.

Johnson, D.W.; D.M. Hildebrand; and F.G. Hawksworth. 1989. Effects of application rate and timing of ethephon treatments on abscission of ponderosa pine dwarf mistletoe. USDA For. Serv., Timber, Forest Pest and Cooperative Forestry Mgmt., Rocky Mountain Region Tech. Rep. R2-44, 9 p.

Johnson, D.W.; L.A. La Madeleine; and W.J. Bloomberg. 1989. Fusarium root rot, p. 40-42. *In*: Cordell, C.E.; et al. [tech. coords.]. Forest Nursery Pests. USDA For. Serv. Agri. Handbook 680. 184 p.

Johnson, D.W.; C.G. O'Neil; and D.M. Haneman. 1989. Forest Pest Conditions in the Rocky Mountain Region for 1988. USDA For. Serv., Timber, Forest Pest and Cooperative Forestry Mgmt., Rocky Mountain Region. 33 p.

Linhart, Y.B. 1989. Interactions between genetic and ecological patchiness in forest trees and their dependent species, p. 393-430. *In*: Bock, J.E.; and Y.B. Linhart [eds.]. Evolutionary Ecology of Plants. Westview Press, Boulder, CO.

Maffei, H.; and J. Beatty. 1989. Changes in the incidence of dwarf mistletoe over 39 years in the Southwest, p. 88-90. *In*: Proceedings of the 36th Western International Forest Disease Work Conference, September 20-23, 1988, Park City, UT. 153 p.

Marsden, M.; and P.M. Hall. 1990. Estimating and predicting multiple pest impacts in forest stands, p. 69. *In*: James R.L.; and R.L. Livingston [compilers]. Proceedings of the Thirty-seventh Annual Western International Forest Disease Work Conference, September 11-15, 1989, Bend, OR. USDA For. Serv., Coeur d'Alene, ID. 154 p.

Nicholls, T.H. 1989. Ethephon tests for lodgepole pine dwarf mistletoe in Colorado, p. 34-36. *In*: Proceedings of the 36th Western International Forest Disease Work Conference, September 20-23, 1988, Park City, UT. 153 p.

Nicholls, T.H.; L.M. Egeland; and F.G. Hawksworth. 1989. Birds of the Fraser Experimental Forest, Colorado, and their role in dispersing lodgepole pine dwarf mistletoe. Colorado Field Ornithologist's Journal 23: 3-12.

Pasek, J.E. 1990. Douglas-fir beetle infestation following the Clover Mist fire on the Clarks Fork Ranger District, Shoshone National Forest, Wyoming. USDA For. Serv., Timber, Forest Pest and Cooperative Forestry Mgmt., Rocky Mountain Region Biol. Eval. R2-90-1, 10 p. (In press).

Pasek, J.E. 1990. Sampling windbreaks for borers and defoliators. *In*: Proceedings of the informal conference "Insects of windbreaks and related plantings: Distribution, importance and management," 1988 National Entomological Society of America Conference, December 4-8, 1988, Louisville, Kentucky. USDA For. Serv. Gen. Tech. Rep. RM- . Rocky Mountain For. and Range Expt. Sta., Fort Collins, CO. (In press).

Pasek, J.E.; and M.E. Dix. 1989. Life history of a ponderosa pine coneworm, *Dioryctria auranticella* (Lepidoptera: Pyralidae). Journal of Economic Entomology 82: 879-885.

Peterson, G.W. 1989. Dothistroma needle blight. p. 34-35. *In*: Cordell, C.E.; et al. [tech. coords.]. Forest Nursery Pests. USDA For. Serv. Agri. Handbook 680. 184 p.

Peterson, G.W.; and C.S. Hodges, Jr. 1989. Phomopsis blight. p. 56-58. *In*: Cordell, C.E.; et al. [tech. coords.]. Forest Nursery Pests. USDA For. Serv. Agri. Handbook 680. 184 p.

Peterson, G.W.; W. Merrill; and D.D. Skilling. 1989. Eastern and western gall rusts. p. 36-37. *In*: Cordell, C.E.; et al. [tech. coords.]. Forest Nursery Pests. USDA For. Serv. Agri. Handbook 680. 184 p.

Peterson, G.W.; and T.H. Nicholls. 1989. Diplodia blight. p. 31-33. *In*: Cordell, C.E.; et al. [tech. coords.]. Forest Nursery Pests. USDA For. Serv. Agri. Handbook 680. 184 p.

Raimo, B.J. 1989. Gypsy moth detection trapping on National Forest System lands in the Rocky Mountain Region. USDA For. Serv., Timber, Forest Pest and Cooperative Forestry Mgmt., Rocky Mountain Region, Bio. Eval. R2-89-1. 10 p.

Riffle, J.W. 1989. Field performance of ponderosa, Scots, and Austrian pines with *Pisolithus tinctorius* ectomycorrhizae in prairie soils. Forest Science 35: 935-945.

Riffle, J.W. 1989. Honeysuckle blight. p. 92-94. *In*: Cordell, C.E.; et al. [tech. coords.]. Forest Nursery Pests. USDA For. Serv. Agri. Handbook 680. 184 p.

Robbins, K.; D.W. Johnson; F.G. Hawksworth; and T.H. Nicholls. 1989. Aerial application of ethephon is ineffective in controlling lodgepole pine dwarf mistletoe. Western Journal of Applied Forestry 4: 27-28.

Ruehle, J.L.; and J.W. Riffle. 1989. Nematodes. p. 122-123. *In*: Cordell, C.E.; et al. [tech. coords.]. Forest Nursery Pests. USDA For. Serv. Agri. Handbook 680. 184 p.

Schmid, J.M.; S.A. Mata; and R.D. Averill. 1989. Containment of small group infestations of the mountain pine beetle in ponderosa pine. USDA For. Serv., Rocky Mountain For. and Range Expt. Sta. Research Note RM-493. 4 p.

Schmid, J.M.; S.A. Mata; and C.B. Edminster. 1989. Frequency of external defect and skidding damage in ponderosa pine stands in the Black Hills. USDA For. Serv., Rocky Mountain For. and Range Expt. Sta. Research Note RM-496. 3 p.

Sharon, E.M. 1989. Mixing interpretive media: Death knell or Creative mind expander? *In*: Proceedings of the 1988 NAI National Interpreters Workshop. 329 p.

Sharon, E.M. 1989. Tree failures, risk and reasonableness. A commonsense approach. Arboricultural Journal 13: 193-209.

Sharon, E.M.; and D. Steinke. 1989. Tree health management: Evaluating trees for hazard. VHS Video. Distributed by the American Forestry Association and the International Society of Arboriculture.

Shaw, C.G., III; and W.M. Ciesla. 1990. International concerns with forest pest management, p. 47. *In*: James R.L.; and R. L. Livingston [compilers]. Proceedings of the Thirty-seventh Annual Western International Forest Disease Work Conference, September 11-15, 1989, Bend, OR. USDA For. Serv., Coeur d'Alene, ID. 154 p.

Souto, D.; and F.G. Hawksworth. 1988. Eastern dwarf mistletoe survey on red spruce in New York, New Hampshire, and western Maine, p. 347-349. *In*: Proceedings of the US/FRG Research Symposium: Effects of atmospheric pollutants on the spruce-fir forests of the eastern United States and the Federal Republic of Germany, October 19-23, 1987, Burlington, VT. USDA For. Serv. Gen. Tech. Rep. NE-120. 543 p.

Staley, J.M.; and T.H. Nicholls. 1989. Lophodermium needle cast, p. 49-51. *In*: Cordell, C.E.; et al. [tech. coords.]. Forest Nursery Pests. USDA For. Serv. Agri. Handbook 680. 184 p.

Swetnam, T.W.; and A.M. Lynch. 1989. A tree-ring reconstruction of western spruce budworm history in the southern Rocky Mountains. Forest Science 35: 962-986.

Vining, J.; and B. Orland. 1989. The video advantage: a comparison of two environmental representation techniques. J. Environ. Manage. 29: 275-283.

Wicker, E.F. 1989. Public involvement in forest health - Who will speak?, p. 58-66. *In*: Proceedings of the 36th Western International Forest Disease Work Conference, September 20-23, 1988, Park City, UT. 153 p.

Wysong, D.S.; M.O. Harrell; D.H. Steinegger; and M.R. Kuhns. 1989. Iron chlorosis of trees and shrubs. Univ. Nebr. Coop. Ext. Serv. NebGuide G84-705. 4 p.

Zentz, W.R.; and W.R. Jacobi. 1989. Ecology of *Comandra umbellata* (Santalaceae) in western Wyoming. Great Basin Naturalist 49: 650-655.

Zimmerman, G.T.; and J. Chonka. 1989. Fire use for disease management in lodgepole pine. Colorado State Forest Service, Burning Issues for Resource Managers in the Rocky Mountain West 3: 1-3.

The use of trade, firm, or corporation names in this publication is for the information and convenience of the reader. No official endorsement or approval by th U.S. Department of Agriculture of any product or service to the exclusion of others which may be suitable is intended.